# COURSE UNIT DESCRIPTION - PHYSICAL AND CHEMICAL METHODS IN BIOLOGY

| Course unit title | Code |
|---|---|
| **PHYSICAL AND CHEMICAL METHODS IN BIOLOGY** | |

| Lecturer(s) | Department(s) |
|---|---|
| **Coordinator:** Prof. Valdas LAURINAVICIUS<br>**Other(s):** | Institute of Biochemistry of Vilnius University, Mokslininkų 12, LT-08662 Vilnius |

| Cycle | Level of the course unit | Type of the course unit |
|---|---|---|
| Full-time studies (1st stage) | 1 out of 1 | Compulsory |

| Mode of delivery | Period of delivered | Language(s) of instruction |
|---|---|---|
| Face to face | 5th semester, autumn | Lithuanian |

| Prerequisites and corequisities | |
|---|---|
| **Prerequisites:**<br>General and physical chemistry, organic and bioorganic chemistry, biochemistry. | **Corequisities (if any):**<br>None |

| Number of credits allocated to the course unit | Student's total workload | Contact hours | Self-study and research hours |
|---|---|---|---|
| **5** | **133** | **64** | **69** |

**Purpose of the course unit: programme competences to be developed**

The course unit aims to develop:

*Subject specific competences:*

- skills to apply concepts of chemistry, physics, mathematics for analysis and description of biological molecules and biological processes;
- skills to select appropriate physical and chemical methods to assess the properties of biological molecules and biological processes

*General competences:*

- analytical and critical thinking
- skills for self-development, learning skills in order to study general science resources;

| Learning outcomes of the course unit | Teaching and learning methods | Assessment methods |
|---|---|---|
| • Explains the main principles of the formation of the analytical task and knows the main ways of the solution of the task, as well as metrological approach of the analytical methods.<br>• Analyses, compares and critically evaluates the chemistry and analytical chemistry information related to this topic. | Lectures, seminars | Midterm exam |
| • Describes principles of application of the optical spectroscopy for the analytical purposes, and principles of the action of such methods.<br>• Analyses, compares and critically evaluates the chemistry and analytical chemistry information related to this topic. | Lectures, seminars | Midterm exam |
| • Describes the main principles of the action of | Lectures, seminars | Midterm exam |

| | | |
|---|---|---|
| electrochemical systems and explains ways of their application for the analytical purposes.<br>• Analyses, compares and critically evaluates the chemistry and analytical chemistry information related to this topic. | | |
| • Describes the supra-molecular forces and mechanisms of the molecular recognition.<br>• Analyses, compares and critically evaluates the chemistry and analytical chemistry information related to this topic. | Lectures, seminars | Midterm exam |
| • Describes the enzyme-based analytical methods, Homogeneous and heterogeneous approaches of the analytical methods, Methods of the immobilization of enzymes.<br>• Analyses, compares and critically evaluates the chemistry and analytical chemistry information related to this topic. | Lectures, seminars | Exam |
| • Describes immunometric and other specific complex producing analytical methods.<br>• Analyses, compares and critically evaluates the chemistry and analytical chemistry information related to this topic. | Lectures, seminars | Exam |
| • Explains artificial recognition systems and their application in analytical methods. Explains main adventures and drawbacks of the analytical methods based on molecularly imprinted polymers, aptamers and phages.<br>• Analyses, compares and critically evaluates the chemistry and analytical chemistry information related to this topic. | Lectures, seminars | Exam |

| **Content: breakdown of the topics** | **Contact hours** | | | | | | | **Self-study work: time and assignments** | |
|---|---|---|---|---|---|---|---|---|---|
| | Lectures | Tutorials | Seminars | Exercises | Laboratory work | Internship/work placement | **Contact hours** | **Self-study hours** | **Assignments** |
| **1. Analytical problem and the ways of the solution** | **4** | | **4** | | | | **8** | **6** | Self-directed learning of the topic-related textbook material, analysis of the topic-related scientific papers. |
| Analytical problem, rates of the process | 2 | | 2 | | | | **4** | **3** | |
| Statistical methods in the laboratory | 2 | | 2 | | | | **4** | **3** | |
| **2. Optical methods of analysis** | **5** | | **5** | | | | **10** | **12** | Self-directed learning of the topic-related textbook material (course virtual learning environment), analysis of the topic-related scientific papers. |
| UV-VIS, IR and atomic spectroscopy in analytical methods | 2 | | 2 | | | | **4** | **4** | |

| | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| Fluorescence in analytical methods | 1 | | 1 | | | | **2** | **4** | |
| Polarized light, scattering and reflectance spectroscopy in analytical methods | 1 | | 1 | | | | **2** | **2** | |
| Surface plasmon resonance methods | 1 | | 1 | | | | **2** | **2** | |
| **3. Electrochemical methods of analysis, sensors** | **5** | | **5** | | | | **10** | **10** | Self-directed learning of the topic-related textbook material (course virtual learning environment), analysis of the topic-related scientific papers. |
| Electrochemical cells and reference electrodes | 1 | | 1 | | | | **2** | **2** | |
| Potentiometric methods of analysis | 1 | | 1 | | | | **2** | **2** | |
| Amperometric methods of analysis | 1 | | 1 | | | | **2** | **2** | |
| Chemical sensors | 1 | | 1 | | | | **2** | **2** | |
| Impedance spectroscopy | 1 | | 1 | | | | **2** | **2** | |
| **4. Biochemical recognition** | **4** | | **4** | | | | **8** | **9** | Self-directed learning of the topic-related textbook material (course virtual learning environment), analysis of the topic-related scientific papers. |
| Covalent bonding | 1 | | 1 | | | | **2** | **2** | |
| Supra-molecular forces | 2 | | 2 | | | | **4** | **4** | |
| Mechanisms of biochemical recognition | 1 | | 1 | | | | **2** | **3** | |
| **5. Enzyme-based analytical methods** | **7** | | **7** | | | | **14** | **18** | Self-directed learning of the topic-related textbook material (course virtual learning environment), analysis of the topic-related scientific papers. |
| Properties of enzymes, methods of the determination of enzyme activity | 1 | | 1 | | | | **2** | **3** | |
| Enzyme inhibition | 1 | | 1 | | | | **2** | **3** | |
| Homogeneous methods of the determination of substrates | 2 | | 2 | | | | **4** | **5** | |
| Heterogeneous methods of the determination of substrates, biosensors | 2 | | 2 | | | | **4** | **4** | |
| Methods of enzyme immobilization | 1 | | 1 | | | | **2** | **3** | |
| **6. Immunometric and other specific complex producing analytical methods** | **4** | | **4** | | | | **8** | **8** | Self-directed learning of the topic-related textbook material (course virtual learning environment), analysis of the topic-related scientific papers. |
| Complex precipitation immunometric methods | 1 | | 1 | | | | **2** | **2** | |
| Radioimmunometric method (RIA) | 1 | | 1 | | | | **2** | **2** | |
| Enzyme linked immunometric methods (ELISA) | 1 | | 1 | | | | **2** | **2** | |

| | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| Immunosensors and DNA-based sensors | 1 | | 1 | | | | **2** | **2** | |
| **7. Artificial recognition systems** | **3** | | **3** | | | | **6** | **6** | Self-directed learning of the topic-related textbook material (course virtual learning environment), analysis of the topic-related scientific papers. |
| Molecularly imprinted polymers (MIP) | 1 | | 1 | | | | **2** | **2** | |
| Aptemers in analytical methods | 1 | | 1 | | | | **2** | **2** | |
| Phages in analytical methods | 1 | | 1 | | | | **2** | **2** | |
| **Total** | **32** | | **32** | | | | **64** | **69** | |

| **Assessment strategy** | **Weight, %** | **Assessment period** | **Assessment criteria** |
|---|---|---|---|
| Midterm exam | 40 | 9th week of the course | Written control report on 4 topics from 5. Each topic scores max. 10 points. Main score – mean of scores of 4 topics |
| Exam | 40 | 16th week of the course | Written control report on 4 topics from 5. Each topic scores max. 10 points. Main score – mean of scores of 4 topics |
| Seminars | 20 | 16th week of the course | Each student prepares 10-15 min. presentation on selected topic. Score of the presentation and discussion max. 10 points x coefficient of the participation in the seminars. |
| Total | 100 | | Mean of the scores of midterm exam and exam x 0.8 + Seminar score x 0.2 |

| **Author** | **Year of publica-tion** | **Title** | **Issue of a periodical or volume of a publication** | **Publishing place and house or web link** |
|---|---|---|---|---|
| **Compulsory reading** | | | | |
| Copies of the Lecture slides and material for the seminars | 2012 | Physical and chemical methods of analysis | | Copies of the slides and material for the seminars will be presents during the first lecture |
| V. Laurinavicius | 2012 | Biochemical methods of analysis (in Lithuanian) | | VU Publishing House |
| **Optional reading** | | | | |
| D. Mickevicius | 1998-1999 | Chemical methods of analysis (in Lithuanian) | Vol I-II | Publ. house "Žiburys" |
| H.U. Bergmeyer (Ed.) | 1983 | Methods of Enzymatic Analysis | Vol. 1 Introduction, Third edition | Verlag Chemie GmbH |
| R. Kelner and oth. (Ed.) | 2004 | Analytical Chemistry. A Modern Approach to Analytical Science | Second edition | Willey-VCH |
| Pingoud A. and oth. | 2003 | Biochemical Methods. A Concise Guide for Students and Researches | | Willey-VCH |